Educating the Engineer of 2020: A Practical Implementation

Lawrence Whitman, Zulma Toro-Ramos, and Steven Skinner
College of Engineering
Wichita State University

Abstract

The College of Engineering (CoE) at Wichita State University (WSU) has launched a strategic initiative, Engineer of 2020, in order to prepare graduates for effective engagement in the engineering profession in the year 2020. This initiative is, in part, motivated by two reports from the National Academy of Engineering, of the National Academies, entitled The Engineer of 2020 and its follow-on report, Educating the Engineer of 2020. These reports, written by two groups of distinguished educators and practicing engineers from diverse backgrounds, were developed in response to a concern that engineering students of today may not be appropriately educated to meet the demands that will be placed on the engineer of the future, without refocusing and reshaping the undergraduate engineering learning experience.

Beginning with the Fall 2007 class, to fulfill the requirements for an Engineering BS degree at WSU, each student will complete the program course requirements including at least three of the following six activities: Undergraduate Research; Cooperative Education or Internship; Global Learning or Study Abroad; Service Learning; Leadership; and Multidisciplinary Education. This program will make the educational experience more meaningful to the student and the student more desirable to local and national industries. This paper describes the details of the requirements at WSU, the resources required, and the linkage to ABET outcomes.

I. Introduction and Motivation

The College of Engineering (CoE) at Wichita State University (WSU) has launched a strategic initiative, Engineer of 2020, in order to prepare graduates for effective engagement in the engineering profession in the year 2020. This initiative is in part motivated by two reports from the National Academy of Engineering, of the National Academies, entitled The Engineer of 2020 [1] and its follow-on Educating the Engineer of 2020 [2]. These reports, written by two groups of distinguished educators and practicing engineers from diverse backgrounds, were developed in response to a concern that engineering students of today may not be appropriately educated to meet the demands that will be placed on the engineer of the future, without refocusing and reshaping the

undergraduate engineering learning experience. In the first report, the group provided guiding principles that will shape engineering activities in 2020:

- The pace of technological innovation will continue to be rapid.
- The work in which technology will be deployed will be intensely globally interconnected.
- The population of individuals who are involved with or affected by technology (e.g., designers, manufacturers, distributors, users) will be increasingly diverse and multidisciplinary.
- Social, cultural, political, and economic forces will continue to shape and affect the success of technological innovation.
- The presence of technology in our everyday lives will be seamless, transparent, and more significant than ever.

The report also states that in order to successfully educate engineers who can effectively contribute in this changing landscape, engineering educators will have to produce graduates who will:

- possess strong analytical skills;
- exhibit practical ingenuity;
- be creative;
- have good communication skills;
- be mastered in the principles of business and management;
- understand the principles of leadership;
- have a strong sense of professionalism and ethical standards; and
- be lifelong learners.

A number of noted engineering education leaders have responded and commented on these reports. Butcher claims the reports call for, "ingenious leaders — ingenious engineers" and calls these engineers, "well-rounded Renaissance Engineer"[s] [3]. Turns, Atman, et al., [4] use these reports as an input to what an engineer needs to know. Dym, et al. present how engineering education is being challenged to require students to consider additional design constraints required as part of a "new fundamentals" [5]. In response to this challenge, the CoE at WSU wishes to establish its leadership in reshaping the undergraduate experience to prepare the engineer of 2020, and at the same time make the educational experience more meaningful to the student and the student more desirable to local and national industries.   As such, the CoE proposes that to fulfill the requirements for an Engineering BS degree at WSU, each student will complete the program course requirements including at least three of the following six activities:

1.	Undergraduate Research
2.	Cooperative Education or Internship
3.	Global Learning or Study Abroad
4.	Service Learning

5. Leadership
6. Multidisciplinary Education

This strategic initiative also takes advantage of the flexibility of the new Engineering Criteria 2000 (EC2000) of the Accreditation Board for Engineering and Technology (ABET), and helps the programs offered by the College to satisfy the criteria and spirit of ABET EC2000. The criteria that each activity may satisfy and the linkages to the Engineer of 2020 are shown in a subsequent section.

The next section presents the definition of each criterion and describes a summary of how the student may fulfill the requirements of the criteria. The proposal and final report approval process is then described. The final section outlines the resources required and presents the implementation plan.

II. Definitions of each criterion

This section of the paper provides a brief definition of each criterion and then follows with more details for satisfying the criterion.

1. Undergraduate Research: Undergraduate research has been considered important for retention and for graduating productive engineers. A study by Zydney, et al. [6] reported that undergraduates who work with a faculty member in research are more likely to continue to graduate school as well as have better ABET "soft skills." The same group completed a follow on study [7] of faculty perceptions concerning undergraduate research and found that faculty were able to mentor students to deeper understanding of concepts. Students work under the supervision of a faculty member either as an undergraduate research assistant for one semester or perform an independent study. The faculty supervising the undergraduate research approves the activity and signs the form.

To satisfy the Undergraduate Research criteria each student must complete one of the following:

1. One full semester as an undergraduate research assistant to a faculty member. The student must also submit/apply to the undergraduate research symposium. The university has developed an undergraduate research symposium forum in which students from all disciplines present their research and awards are given to the best research presentation.

2. An independent study, under the guidance of a faculty member, performing a comprehensive and critical literature review of an emerging area of research (analysis/synthesis of the current state of knowledge in that area).

The proposal must be approved by the faculty advisor, contain a description of the research tasks including items from the discipline specific body of knowledge, and must identify one or more of the ABET criteria involved in the research task. The final report must include: problem statement, objectives, the method, possible solutions, selection of final recommendations, and engineering skills/techniques used. Students who wish to use this criterion will be encouraged to make contact with faculty in their desired area of research during their sophomore year.

2. Cooperative Education/Internship: Cooperative education has been around a long time and with many different implementations and a good review of these can be found by Akins[8]. To satisfy the Cooperative Education or Internship criteria each student must complete one of four tracks available: Cooperative Education, Internship, Combination, or Industrial Experience. Students who wish to use this criterion will be encouraged to contact the Office of Cooperative Education during the first semester of their sophomore year or during the summer immediately following their freshmen year. Students will complete the orientation process and will need to meet the program requirements established by the College of Engineering. Employers who participate in cooperative education with WSU are asked to agree to a statement of understanding. As part of this strategic initiative, WSU will apply for accreditation through the Accreditation Council for Cooperative Education (ACCE).

Cooperative Education Track

To successfully complete the internship track, students will:

- Complete two to four semesters of cooperative education work sessions, including no more than two summer semesters using the following models:
    - Alternating positions require a multiple-semester commitment and 40 hours per week,
    - Alternating placements: Full-time work placements alternating with fulltime classroom study. Two semesters totaling at least 30 weeks,
    - Parallel positions require a multiple-semester commitment and 20 hours per week,
    - Parallel placements: Half-time work placements coupled with at least half-time classroom study. Four semesters totaling at least 60 weeks,
    - Combination Alternating/Combination Parallel, and
    - Combination Alternating plans meet the defining features of full-time alternating models, in addition, they include one or more parallel components. Combination Parallel plans meet the defining features of parallel models; in addition, they include one or more periods of non-alternating full-time work. Combinations of parallel and full-time work-experience could be (1) full-time

coupled with (2) part-time placements resulting in the approximate equivalent of 30 full-time workweeks.

- Enroll in one credit hour of cooperative education during each of the semesters
- Earn two to four hours of cooperative education credit that count toward their technical elective requirement
- Establish a relationship with a faculty advisor to ensure a connection between topics learned in the classroom and skills used on the job
- Complete cooperative education academic requirements, as established by each department, during each semester of enrollment
- Maintain the minimum GPA (3.0) established by the College during all four semesters. Students who fall below the GPA requirement will be placed on cooperative education probation and will have one semester to raise their GPA.

Students will be strongly encouraged to work for the same employer during all work sessions.

A cooperative education endorsement will be noted on a student's transcript if the University records satisfactory performance during all work sessions and the student meets all cooperative education requirements.

Internship Track

To successfully complete the internship track, students will:

- Complete at minimum two semester-long internships; summer counts as a semester
- Enroll in one credit hour of internship credit during each of the two semesters
- Earn two hours of internship credit to count toward their technical elective requirement
- Establish a relationship with a faculty advisor to ensure a connection between topics learned in the classroom and skills used on the job
- Complete internship academic requirements, as established by each department, during each semester of enrollment
- Maintain the minimum GPA (3.0) established by the College. Students who fall below the GPA requirement will be placed on internship probation and will have one semester to raise their GPA.

Students will be encouraged to intern at different employers during each semester.

An internship endorsement will be noted on a student's transcript if the University records satisfactory performance during the two work sessions and the student meets all of the internship requirements.

Combination Track

Some students desire the opportunity to have a variety of work experiences. The Combination Track will address these students' needs. To successfully complete the combination track, students will:

- Complete at minimum two semesters of cooperative education work sessions and a one-semester internship
- Enroll in cooperative education /internship course during each semester of work experience
- Earn three hours of internship credit to count toward their technical elective requirement
- Establish a relationship with a faculty advisor to ensure a connection between topics learned in the classroom and skills used on the job
- Complete cooperative education /internship academic requirements, as established by each department, during each semester of enrollment
- Maintain the minimum GPA (3.0) established by the College during all three semesters. Students who fall below the GPA requirement will be placed on internship probation and will have one semester to raise their GPA.

Students will be encouraged to spend their two semesters of cooperative education working with one employer and their one semester of internship working with a different employer.

An endorsement will be noted on a student's transcript if the University records satisfactory performance during the work sessions and the student meets all of the cooperative education/internship requirements.

Industrial Experience Track

Some students work with employers who have yet to form a cooperative education or internship agreement with WSU. The Industrial Experience Track provides these students a means by which to validate their industrial experience as fulfilling the cooperative education and internship criteria. A valid work experience will involve the application of engineering principles and must be approved by the student's academic department. This track does not provide academic credit hours toward degree. To successfully complete this track, students will:

- Submit a proposal, that identifies the work experience, to their academic department for approval
- Complete at minimum two semester-long (full time) or four semester-long (part time) approved work experience; summer counts as a semester
- Establish a relationship with a faculty advisor to ensure a connection between topics learned in the classroom and skills used on the job

- Complete internship or cooperative education academic requirements, as established by each department, during each semester.

As can be seen by the details described in this section, there are a variety of options for students to achieve practical experience to fulfill this criterion. As Wichita State University is in a diverse area, students have a wide variety of options available to them to acquire practical experience. Therefore, this diversity of experiences is encouraged for the engineer of 2020 at WSU.

3. Global Learning/Study Abroad: Many have presented the need for engineers to be more aware of global issues, cultural concerns, and even global constraints in design. In fact, Shuman, et al. [9] state that future engineering graduates need "to become highly innovative global 'problem solvers.'" Downey, et al.[10] present the required competencies for an engineer to be "globally competent." Global learning may even impact the lifelong learning of graduates. As students become more aware of differences in clusters, even in engineering design, they realize their need to learn throughout their lives[11]. Students participate in a global learning project within a class at WSU or complete credit bearing classes in a foreign country. The faculty teaching the global learning class or the Office of International Programs approves the activity and signs the form.

Global learning is defined as the combination of global reach, achieved with modern communication technology, and global perspectives arising from interaction between students living in different countries, to educate the global citizen. Features of global learning include:
- An authentic and substantive goal, such as producing a design for a client or solving an engineering problem
- Working in a team with people living in other countries or with a client from another country
- A focus on requiring the students to learn more about culture through improving their intercultural communication competence
- Opportunities for professional presentation of the global learning experience

Integration of global learning into an engineering course involves changes to the learning strategy, taking it from a didactic/pedagogical approach to a heutogogical[1] approach that involves autonomous learning. Typically, students will need to learn in a team towards some substantive and authentic goal. In the

---

[1] Heutagogy (often interpreted as a theory of self-determined learning) recognizes that the learning environment needs to be flexible and provide conditions for self-directed (autonomous) learning. In the educational setting, to better meet needs of a learner, the teacher provides goals and resources but the actual course of learning is more flexible and negotiable. In the context of the WSU Engineer of 2020, providing choices for students (selecting three out of six possibilities) is a good example. Furthermore, current learning theories put more emphasis on experiential learning ("learning by doing"). That idea is integrated in the concept of "heutagogical learning" (Alagic, 2006).

process, they must be able to communicate effectively. That, in turn, requires them to understand the perspectives of each other and themselves, improving their intercultural communication competence.

Typically, students will need to learn in a team towards some substantive and authentic goal. In the process, they must be able to communicate effectively. That, in turn, requires them to understand the perspectives of each other and themselves, improving their intercultural communication competence.

Examples of global learning include the following existing courses:
ME 662. A senior design course in which students develop a design for a foreign sponsor or to work in multicultural teams for a foreign sponsor. Currently involves Russia and India.
IME767. Lean Manufacturing – students interacting with others from overseas institutions to improve the efficiency of a manufacturing line, using virtual reality software.
Robots Around the World – designed to increase interest in engineering and science in schools through a competition for LEGO robotics designs, extended to involve people in other countries.

Study abroad is defined simply as participating in a program of study overseas. The program must be approved by the Office of International Education and the student's advisor, and any courses taken must be approved by the College of Engineering for course credit toward the student's academic program. In general, the course should be for-credit and should be one semester in length or equivalent.

To satisfy the Global Learning or Study Abroad criteria each student must complete one or more of the following:

1. Successfully participate in a global learning project within an existing class; this will typically involve internet-based communications with students, teachers, and colleagues in at least one other country. Global learning projects must include at least one participant from outside the English-as-a-first-language world (e.g. Russia, Japan, China) to be eligible.

2. Successfully complete a study abroad component; this involves participating in a credit-bearing, university-approved study abroad activity in a foreign country. (Note: Students possessing an F-1 VISA qualify for this criteria and must submit a form to the Director of Engineering Education.)

3. Submit a previous global learning or study abroad experience; in this case, the student must prepare a two-page report outlining:
   - Summary of previous experience, including dates and locations

- Description of the student experience (typically a reflective paper, though not restricted to this)
- Contact information of faculty/sponsors involved in the global learning experience

4. Service Learning: Students participate in a project in a credit-bearing class that serves the community's needs as part of the engineer's responsibility to society. The faculty supervising the service learning approves the activity and signs the form. Dym [5] also discussed the combining of service learning and Design. Some even state that service learning affects the ethics of student behavior [12]. A review of service learning in engineering can be found in [13] and [14].

Service learning is broadly defined by the following:
- It is an educational experience that is course-based and credit-bearing.
- Is an organized service activity consisting of an intentional and thought-provoking application of classroom learning to active and engaging work by participating in a group project that meets identified community needs.
- It includes structured reflection on the service activity to gain further understanding of course content, a broader appreciation of the discipline, and an enhanced sense of civic responsibility [15]; [16].
- A Community is broadly defined and opportunities for service can address a wide variety of community needs.

To satisfy the curricular requirements of Service Learning, each student will complete one of the following:

1. A project that meets the criteria of service learning as a significant component of a one-semester, for-credit existing course. For example, two existing courses that could have service learning options are Engineering 101 and the Senior Design Classes.

2. A one-semester, for-credit Independent Study course that meets the criteria of service learning. Each student will enroll in the Independent Study course of their major, and will work in multidisciplinary, cross-College teams. Each student will have a faculty mentor from their home department.

The process of selecting community service projects will include two major steps:

1. Solicitation of Community Service Project requests. A process for requesting proposals from the community will be developed, and will involve other campus entities as appropriate. For example, the Cooperative Education Program and other campus entities (for example, the School of Social Work) can help identify potential community

partners. Solicitation materials can include examples of the types of projects that would meet the goals of service learning.

2. Selection of Community Service Projects can proceed by way of committee review of proposals, with selection based on overall quality of the proposals in terms of:
   a. potential to meet a community need
   b. potential to further student learning
   c. feasibility in terms of skills and time required for completion

5. Leadership: To graduate successful practicing engineers, these engineers must "have developed skills in talking through material with peers, listening with real skill, knowing how to build trust in a working relationship, and providing leadership to group efforts [17]." Leadership skills are vital to become a success engineer. Leadership is here defined as the knowledge and practice of skills necessary to lead a team to accomplish a common goal. Students participate in formal instruction and lead a project or have previous leadership experience. The student completes a project report and submits to the Director of Engineering Education.

To satisfy the Leadership criteria each student must:

- Take some formal instruction on leadership
- Propose and demonstrate a leadership experience
- Submit a short report on the experience.

Leadership instruction is necessary in order for the student to gain the skills necessary to be an effective leader. If a student had already demonstrated leadership in some role or activity and submitted a report documenting the experience, then this requirement could be waived. The course/workshop should have the following objectives:

Students will be able to:

- Demonstrate the ability to communicate leadership knowledge verbally and in writing.
- Critically examine, explore, and evaluate the usefulness of leadership concepts.
- Demonstrate effective team leadership skills.
- Regularly assess one's knowledge base and skills, and seek additional information to build leadership capability.
- Recognize and value the role of life-long learning, self-assessment, and critical thinking in leadership development.

There are three present courses at WSU that will qualify:

1. PSY 346 (same as PHS 308), Leadership in Self and Society, which will count as a General Education – Social and Behavioral Sciences issues and perspectives course (WSU general education requirement),
2. HNRS 152F, Leadership: Personal and Organizational Challenges for Change, and
3. MGMT 360, Management and Organizational Behavior, which will need to count as a program Technical Elective.

Two more options should be considered as a future possibility:

1. Develop a leadership course within the College of Engineering that would count as a program Technical Elective and
2. Develop a leadership course for engineers outside the College of Engineering. This could possibly be from the College of Education or College of Heath Professionals.

Leadership Experience

This could be any activity or experience that demonstrates leadership and does not have to be confined to university activities. A wide variety of experiences exist including Eagle Scout projects, community or faith based projects, and leadership in student and professional societies. The experience must be first proposed in order to be sure that it qualifies. Note that a leadership position in a student professional society may qualify for this experience, but simply because a student is in a leadership position does not necessarily constitute a leadership experience. The student experience should include a demonstration of most of the following skills: effective communication, ability to manage and influence people, organization, planning, critical thinking, decision making, team collaboration, and life-long learning

6. Multi-Disciplinary Education: A broad education has always been considered an important part of any undergraduate degree. Gorman[18] describes how multi-disciplinary teams can impact the ABET criteria three outcomes. Students obtain a minor or second major outside their engineering discipline. The student submits a form to the Director of Engineering Education documenting completion of this criterion.

Students are multi-disciplinary if they grow academically in areas outside their engineering majors. To satisfy the multi-disciplinary experience, each student will obtain a minor or second major. It should be noted that obtaining a two year Associates Degree along with a Bachelor's engineering degree does not constitute a multi-disciplinary education.

III. Approval Process

Students are responsible to follow this process to ensure that activities meet the requirements of each criterion. The statements below describe who is responsible for approving each activity.

Undergraduate Research: The faculty supervising the undergraduate research approves the activity and signs the form.

Cooperative Education/Internship: The activity is evaluated by the department and the department cooperative education coordinator signs the form.

Global Learning/Study Abroad: The faculty teaching the global learning class or the Office of International Programs approves the activity and signs the form.

Service Learning: The faculty supervising the service learning approves the activity and signs the form.

Leadership: The student completes a project report and submits to the Director of Engineering Education.

Multi-Disciplinary Education: The student submits a form to the Director of Engineering Education documenting completion of this criterion.

A board of review will also be established in the college. The board will be comprised of at least one member from each engineering department, at least one undergraduate student and the Director of Engineering Education. The board will meet once per semester. The board will discuss any changes in the documentation or procedures of this program as this is a living process and may change over time.

To document the progress of student's in completing the 2020 criteria, the "Degree Compliance" option in the university computing system will be used. The record of a student completing the requirement upon approval of the final report by the board will be notated in this system. Upon successful completion of three of the six criteria, the student transcript will be annotated with the statement, "Successfully completed the Engineer of 2020 requirements."

IV Projected Requirements

A benchmark was estimated for the number of students opportunities required for each criterion based on a survey performed with students just prior to engineering open house in 2006. The survey asked engineering students to choose three of the 2020 criteria. The projected need for additional student opportunities to complete the criteria is shown in table 1. The first column, % of Student Selections, lists student preferences as identified from the survey of 318 students. The second column represents the best estimate of the current number of students participating in each qualifying criterion. The third column uses a base of 180

students per class multiplied by the % of student selections column to determine the required number of student opportunities. The difference between the last two columns identifies the gap requiring additional resources.

Table 1. Projected Need for Opportunities

Educational Component	% of Student Selections	Current number of students participating in a year	180/class Proj. Enroll. (Per AY)
Undergrad Research	65%	33	117
Cooperative Education /Internships	69%	119	250[1]
Global Learning/Study Abroad	23%	26	41
Service Learning	46%	5	83
Leadership	31%	6	56
Multidisciplinary Ed.	53%	22	95

[1] – 124 need per class (two year requirement) leads to approximately 250 enrolled at any one time to meet the perceived demand.

V. Resource plan

This section describes an initial plan to close the gap between the current number of students participating and the number required.

Undergrad Research – The college has a multi-faceted approach to increase the opportunities for undergraduate research. All existing NSF grantees will be strongly encouraged to recruit students for Research Experiences for Undergraduates (REU) for NSF grantees. Similarly, all new proposals (for both external and internal funding) will be encouraged to have line item funding in the proposed budget for undergraduate students. New college funding has been acquired to hire additional undergraduate research students. These students will be assigned primarily to new faculty. The Faculty Activity Report (FAR) will include a section on number of undergraduate students supervised (including both funded and unfunded). Finally, to recognize faculty who are active with undergraduate research, awards will be provided for faculty of $1000 (1st), $500(2nd), $250 (3rd) if student supervised wins the Undergraduate Research Forum (university wide competition).

Cooperative Education/Internships – Plans are in place to double cooperative education opportunities.

Global Learning/Study Abroad – There are currently two global learning designated classes in the college of engineering (ME662, IME767). This type of offering will be expanded to the other two departments to provide an opportunity for students in all departments. The Boeing Distinguished Professor of Global Learning will assist faculty in each department in implementing global learning in classes. Additional opportunities will be solicited by the Office of International Programs for students to spend a semester abroad. Additionally, international students and those who spent a high school year abroad are considered to have fulfilled this criterion (all of these activities must be with non-native English speaking countries). Additionally, the college is pursuing the possibility of funding for scholarships for students to spend an additional year towards an engineering degree if the student studies abroad.

Service Learning – Many additional proposals will have to be solicited to reach the projected number of student opportunities for this criterion. The proposed plan is that the cooperative education office will manage the solicitations and the receipt of the proposals. These proposals will then be made available to the departments for consideration for senior design and other class projects. Potential projects include past associations with Center Industries Corporation, Goodwill Industries, City of Wichita, Red Cross, Via Christi Hospital and others. These organizations and others will be solicited for student service learning opportunities.

Leadership – Currently three courses at WSU are acceptable. It appears that capacity is currently available. However, more students may actually take this option with the implementation of the 2020 program. Therefore, the College of Engineering may need to develop an additional course to provide theory on leadership.

Multidisciplinary Education – This criterion allows a second major or a minor. Students, when informed of the requirements will schedule their courses to meet these requirements.

Summarizing the resources required, several activities are required of the College of Engineering. All faculty will be encouraged to utilize undergraduates (both funded and unfunded) in their research. One (or group of) faculty in the college may be required to develop a new course on leadership. Additional funds for administering and education for the success of the program are required. There needs to be advising of students to ensure understanding of requirements to comply with the program. Tracking of students and maintaining of records in a detailed and proactive manner is also vital to program success. The Engineer of 2020 requirements will need to be added to the senior check performed for students. The advising of students should include a written plan by the end of each student's sophomore year. In additional to college requirements, resources are also required from other university resources.

VI Link to ABET outcomes

Program outcomes are statements that describe what students are expected to know and be able to do by the time of their graduation. These outcomes must be demonstrated by the student as part of a comprehensive assessment process. In order to satisfy the Program Outcomes and Assessment criterion, engineering programs must demonstrate that their students attain:

a) an ability to apply knowledge of mathematics, science, and engineering
b) an ability to design and conduct experiments, as well as to analyze and interpret data
c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
d) an ability to function on multi-disciplinary teams
e) an ability to identify, formulate, and solve engineering problems
f) an understanding of professional and ethical responsibility
g) an ability to communicate effectively
h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environment, and societal context
i) a recognition of the need for, and an ability to engage in, life-long learning
j) a knowledge of contemporary issues
k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

The activities that the students experience as part of the Engineer of 2020 initiative will allow the student to fulfill ABET outcomes (a) – (k) as shown in the matrix below.

Engineer of 2020 Experience	ABET Criteria 3										
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)
1a. Research Project		✓					✓		✓	✓	✓
1b. Research Ind. Study							✓		✓	✓	
2. Co-op or Internship	✓		✓		✓	✓	✓	✓	✓	✓	✓
3a. Global Learning	✓	✓	✓	✓	✓	✓	✓				
3b. Study Abroad							✓				
4a. Service Learning Project	✓		✓	✓	✓	✓	✓	✓		✓	✓
4b. Service Learning Ind Stdy	✓		✓		✓		✓	✓		✓	✓
5. Leadership				✓		✓	✓				
6. Multidisciplinary Education			✓					✓	✓	✓	

Conclusion

The student experience in the College of Engineering at Wichita State University is a holistic approach that addresses the total student. The National Academy of Engineering reports, "The Engineer of 2020" and "Educating the Engineer of 2020" have assisted in establishing the criterion for an engineer that can add value

to a company and to society as well in the year 2020 and beyond. This paper presented an overview of the current plans for implementation at WSU.

References

[1] Schuermann, Allen; Herring, Bruce, Production System Simulator: PROSIM PC, Oklahoma State University, Spring 2000.

[2] Narayanan, S.; Bodner, Douglas; Sreekanth, Uday; Govindaraj, T.; McGinnis, Leon; Mitchell, Christine, "Research in object-oriented manufacturing simulations: an assessment of the state of the art," IIE Transactions, v30, n9, Sept. 1998, p. 795.

The Engineer of 2020, National Academy of Engineering, Washington, D.C.: The National Academy Press, 2004.

Biographical Information

Lawrence E. Whitman is the Director of Engineering Education for the College of Engineering and an Associate Professor of Industrial & Manufacturing Engineering at Wichita State University. He received B.S. and M.S. degrees from Oklahoma State University. His Ph.D. is from The University of Texas at Arlington is in Industrial Engineering. He also has 10 years experience in the aerospace industry. His research interests are in enterprise engineering, engineering education and lean manufacturing.

Zulma Toro-Ramos serves as Dean of the College of Engineering and Professor of Industrial and Manufacturing Engineering at Wichita State University since 2005. She received a B.S. in Industrial Engineering from the University of Puerto Rico and a M.S. in Industrial and Operations Engineering in from the University of Michigan. She also holds a Ph.D. in Industrial and Systems Engineering from Georgia Institute of Technology. Dr. Toro-Ramos has been in academic administration for over sixteen years. Her research interests include engineering education, broadening the participation in higher education and transformation of institutions of higher education.

Steven R. Skinner is a Professor and Chair of the Department of Electrical and Computer Engineering. He received his B.S. M.S. and PhD degrees from The University of Iowa. His research interests include quantum computing and optical networking.

1. Engineering, N.A.o., *The Engineer of 2020: Visions of Engineering in the New Century*. 2004, Washington, DC: The National Academies Press.
2. Engineering, N.A.o., *Educating The Engineer of 2020: Adapting Engineering Education to the New Century*. 2005, Washington, DC: National Academies Press.
3. Butcher, D.R. (2006) *Redefining Engineering for the Year 2020*. ThomasNet.Com Industrial Market Trends **Volume**,
4. Turns, J.C.J.A.R.S.A.T.B., *Research on Engineering Student Knowing: Trends and Opportunities*. Journal of Engineering Education, 2005: p. 27-41.
5. Dym, C., L.; Agogino, Alice, M.; Eris, Ozgur; Frey, Daniel, D.; Leifer, Larry, J.;, *Engineering Design Thinking, Teaching, and Learning*. Journal of Engineering Education, 2005. **94**(1): p. 103-119.
6. Zydney, A.L.J.S.B.A.S.K.W.B., *Impact of Undergraduate Research Experience in Engineering*. Journal of Engineering Education, 2002. **91**(2): p. 151-157.
7. Zydney, A.L.B., J. S.; Shahid, A.; K. W. Bauer, *Faculty Perspectives on the Undergraduate Research Experience in Science and Engineering*. Journal of Engineering Education, 2002. **91**(3): p. 291-297.
8. Akins, T., *A Brief Summary of Cooperative Education: History, Philosophy, and Current Status*, in *Educating the Engineer of 2020*. 2005, National Academies Press.

9.   Shuman, L.J., M. Besterfield-Sacre, McGourty, Jack, *The ABET 'Professional Skills'-Can They Be Taught? Can They Be Assessed?* Journal of Engineering Education, 2005. **94**(1): p. 41-56.

10.   Gary Lee Downey, J.C.L., Barbara M. Moskal, Rosamond Parkhurst, Thomas Bigley, Chris Hays, Brent K. Jesiek, Liam Kelly, Johnson Miller, Sharon Ruff, Jane L. Lehr, and Amy Nichols-Belo, *The Globally Competent Engineer: Working Effectively with People Who Define Problems Differently.* Journal of Engineering Education, 2006 **95**(2): p. 107-138.

11.   Ramos, F.V. *Educating the Global Engineer.* in *The International Millennial Conference on Engineering Education.* 2000.

12.   Grasso, B.M.a.D., *Socially-Relevant Design: The TOYtech Project at Smith College.* Journal of Engineering Education, 2002: p. 319-326.

13.   Tsang, E., *Design That Matters: Service-Learning in Engineering.* 2000, Washington, DC.: American Association of Higher Education,.

14.   Duffy, J.T., E.; Lord, S. *Service-Learning in Engineering: What, Why, How?* in *Proceedings 2000 ASEE Annual Conference.* 2000. St. Louis, MO.

15.   Bringle, R.G., & Hatcher, J.A., *Implementing service learning in higher education.* Journal of Higher Education, 1996. **67**: p. 221-239.

16.   Totten, S.J.P., *Social Issues and Service at the Middle Level.* 1997, Neddham Heights, MA: Allyn and Bacon

17.   Smith, K.A., Sheri D. Sheppard, David W. Johnson, and Roger T. Johnson, *Pedagogies of Engagement: Classroom-Based Practices.* Journal of Engineering Education, 2005. **94**(1): p. 87-101.

18.   Gorman, M.E., *Turning students into professionals: Types of knowledge and ABET engineering criteria.* Journal of Engineering Education, 2002.